Teacher Beliefs about Effective Science Teaching (TBEST) Questionnaire User Manual

Introduction

Efforts to improve science teaching and learning often involve professional development to deepen teacher content and pedagogical content knowledge, in the belief that enhancing teacher knowledge will lead to improved classroom practice. Teachers' attitudes and beliefs about teaching and learning are critical as well. Unless teachers are willing to change their instruction consistent with what they are learning in the professional development, classroom practice will not improve.

Every aspect of teachers' practice is affected by their beliefs and attitudes; not only the teaching strategies they use in the classroom, but even decisions about what professional development to attend. Numerous studies provide evidence for the impact of teacher beliefs on science instruction. The constructs studied include teacher self-efficacy, attitudes toward science as a discipline, beliefs about learning science, and beliefs about teaching science. Teacher beliefs and attitudes about science as a discipline have been shown to affect lessons about the nature of science (Brickhouse, 1990). Epistemological beliefs influence teacher choices about instructional strategies and the implementation of curricula (Cronin-Jones, 1991).

Several well-documented measures exist to measure teacher self-efficacy (e.g., Riggs & Enochs, 1990), teacher attitudes toward science (e.g., Cobern, 2002), beliefs about science teaching environment (Lumpe, Haney, & Czerniak, 2000), beliefs about the nature of science (e.g., Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002), and beliefs about science teaching and learning (e.g., Sampson & Benton, 2006; Luft & Roehrig, 2007). Despite the large number of existing instruments, none explicitly reflect current cognitive science literature such as that summarized in *How People Learn* (National Research Council, 2000). An interest in how teachers' views about science teaching and learning align to this literature led to the development of a new instrument—the Teacher Beliefs about Effective Science Teaching (TBEST) Questionnaire

This user manual describes the background, development, measurement properties, and appropriate uses of the questionnaire.

Background

Horizon Research, Inc. (HRI) developed the TBEST Questionnaire as part of two larger studies: Assessing Teacher Learning About Science Teaching (ATLAST) and Assessing the Impact of the MSPs: K–8 Science (AIM). Both were funded by the National Science Foundation (ATLAST, DUE-0335328; AIM, DUE-0928177.[1] Specifically, the studies investigated

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[1] Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

relationships among professional development, teacher attributes, classroom practice, and student learning. A simplified theory of action of professional development is shown in Figure 1. Of all the teacher factors that may affect student learning—many more than the studies could account for—we chose three that are often the focus of professional development: teacher subject matter knowledge, pedagogical content knowledge,[2] and beliefs about effective science instruction. The purpose of the TBEST was to allow us to investigate teacher beliefs as both a dependent variable (an outcome of professional development) and as an independent variable (a predictor of classroom practice and student learning).

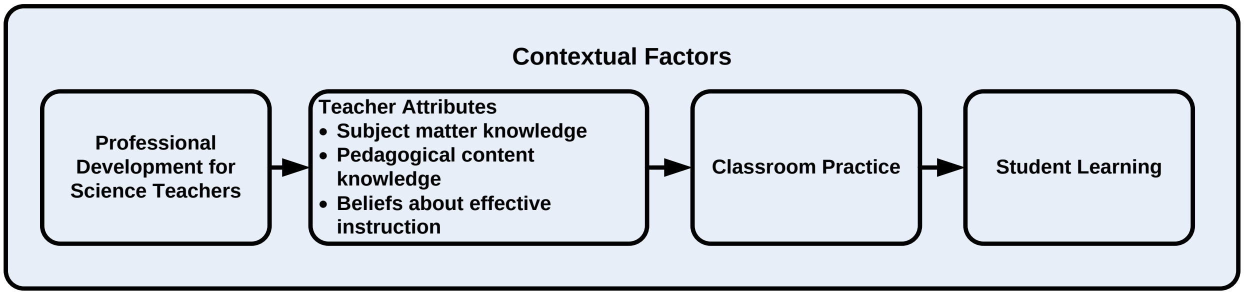

Figure 1

We chose to base the TBEST on an instructional model (Banilower, Cohen, Pasley, & Weiss, 2008) informed by the research on learning summarized in the National Research Council's volumes *How People Learn: Brain, Mind, Experience, and School* (2000) and *How Students Learn: Science in the Classroom* (2005). The model does not prescribe specific pedagogies. Rather, it describes five elements of instruction for teaching a specific science idea, each of which could be accomplished using a variety of pedagogies. The elements are: motivating learners, surfacing their prior knowledge about the idea, engaging learners with phenomena that provide evidence for the idea, using evidence to make and critique claims, and making sense of the targeted idea. These elements, as described by Banilower et al. (2008), are summarized briefly below.

Motivation

Effective instruction ensures that students are motivated, either intrinsically (e.g., by a discrepant event, providing a real-world context, or a problem to solve) or extrinsically (e.g., by grades or tests).

Surfacing Prior Knowledge

Students come to school with ideas and beliefs—gleaned from books, television, movies, and real-life experiences—which may facilitate or impede learning. Surfacing prior knowledge is important so teachers can plan and adjust instruction accordingly. Students also benefit from being aware of their prior thinking, as it provides them with ideas to test and facilitates metacognition.

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[2] Magnusson, Krajcik, and Borko (1999) provide a thorough treatment of the distinction between subject matter knowledge and pedagogical content knowledge for science teaching. In their framework, subject matter knowledge contributes to but is distinct from pedagogical content knowledge.

Engaging with Phenomena

Consistent with the nature of science, effective science instruction should intellectually engage learners with phenomena that provide evidence for the target idea. Although hands-on experiences may be necessary for students to learn some ideas, particularly ones students have strongly held naïve conceptions about, classroom experiences do not always have to be hands-on in order to engage students. Students can be intellectually engaged with an interactive lecture that encourages them to consider examples of the idea from their everyday lives. If hands-on experiences are used, they should reliably provide evidence for the target idea. An experiment that does not adequately control variables, is prone to large measurement error, or is otherwise likely to yield flawed data, may result in students drawing conclusions that are supported by their data, but are inconsistent with the accepted scientific view.

Using Evidence

Science is an evidence-based discipline, and having learners use evidence to make and critique claims models the practice of science and facilitates learning. Cognitively, using evidence from the phenomena they have engaged with helps learners make the connections between the instructional activities and the learning goals. In addition, the more evidence for an idea learners engage with, the more likely they will be to reconsider and reconcile their initial ideas with the more scientifically accepted ideas.

Making Sense

Effective science instruction requires explicit opportunities for students to make sense of the ideas they have explored. Sense making can occur in a variety of ways. Students may be encouraged to make connections between what they did in the lesson and what they were intended to learn so that they see a purpose to their activities. Students may also be asked to reflect on their initial ideas, becoming aware of how their thinking may have changed over the course of the lesson or unit. Another aspect of sense-making involves helping students connect the target ideas to what they have learned previously, organizing their new knowledge in a larger cognitive framework. Finally, students may be given opportunities to apply the concepts to new contexts, helping to reinforce their understanding of and increase their facility with the ideas.

Development of the TBEST Questionnaire

Clarifying the Content Domain

In prior work, we developed a rigorous process for creating science assessments for teachers, and it seemed appropriate to apply this process in developing a questionnaire on teacher beliefs about science teaching. The process begins with identifying the content domain and carefully unpacking, or deconstructing, it. Using the cognitive science research synthesized in *How People Learn* (National Research Council, 2000) and summarized in Banilower et al (2008), we identified *teacher beliefs about effective science teaching* as the “content domain.” In our assessment development framework, each of the elements of effective instruction is analogous to a learning goal. Our next step was to unpack each goal, or element, into discrete, assessable statements. An example is shown in Table 1.

Table 1
Unpacking an Element of Effective Science Instruction into Discrete Statements

Element of instruction: *Instruction should* ***engage the learner with phenomena*** *that yield data and evidence related to the targeted content.*
Statements
Students should have opportunities to engage with phenomena that provide data that are relevant to the targeted content.
Students should have opportunities to engage with phenomena that are appropriate in terms of the students' life experiences.
Students should have opportunities to engage with data that are sufficiently precise to form the science concept.
Students should have opportunities to engage with phenomena for which students can collect their own data.

Item Development

The next step in the development process was to write survey statements related to each sub-idea. This process generated spirited discussions among researchers about what effective science instruction looks like. A common refrain was, "It's not practical to incorporate all of the elements all of the time." That is, if teachers always include all of the elements in their instruction, they would not be able to address all of the content they are charged with teaching. We also had lengthy discussions about whether all of the elements are necessary for every science concept. Some researchers argued that cognitive science literature has been shaped substantially by studies in the physical sciences, in which students tend to have deeply held misconceptions. In these areas, research suggests that students need to experience all of the elements in order to form concepts that align with current scientific thinking. Guidance from research is less clear when students do not have strongly held misconceptions. For example, our assessment development work suggests that students often do not have strongly held misconceptions about Earth's tectonic plates. Students often have misinformation, but they have not formed incorrect ideas through daily interactions with plates. Ultimately, we decided that it was not feasible for the TBEST to be concept specific and that it would instead be consistent with cognitive science findings, even if that research was not completely representative of all science topics.

We also decided to ask teachers to ignore practical constraints of the classroom. Each time we tried to account for these constraints, the questions became more about what teachers actually do in the classroom than about their beliefs. We constructed the following preamble in the instructions for the questionnaire:

> *We recognize that teachers have to make many trade-offs when they are responsible for teaching many standards in one year. Teachers may not be able to emphasize the instructional strategies they believe are effective and still cover the entire curriculum. When you respond to the statements below, we ask that you put those trade-offs aside. Imagine that you have no constraints, including state/district standards, available time and resources, and feasibility. We want to know what you think effective instruction looks like, without all the constraints that limit what you can do in the classroom.*

Discussions about response options also occupied many development meetings. For the initial version of the questionnaire, we eventually settled on two response-option formats: agreement and importance. The stem for the first asked teachers whether they agreed with each statement. The second asked teachers about the importance of students experiencing what was described in the statement. To the extent possible, we wrote parallel versions of statements for each response-option format, as we thought it was important to test both and learn which one produced greater variation in teacher responses.[3] For example, a statement about eliciting students' prior knowledge resulted in the following two items:

- Practical constraints aside, do you *agree* that doing what is described in each statement would help most students learn science?
    - Teachers should be aware of their students' prior knowledge of a science topic before the lesson begins. (four response options ranging from "strongly disagree" to "strongly agree")
- Practical constraints aside, how *important* is each of the following for helping students learn science?
    - Teachers are aware of their students' prior knowledge of a science topic before the lesson begins. (seven response options ranging from "very important that this does not happen" to "very important that this does happen")

Using this approach, we wrote multiple statements for each sub-idea. We then conducted cognitive interviews (Desimone & Le Floch, 2004) about the items by telephone with 17 middle grades science teachers throughout the United States. The purpose of these interviews was to ensure that teachers interpreted the statements as we intended. One issue that arose during the interviews illustrates the importance of these conversations in the development process. Many of the science education reform documents (e.g., National Research Council, 1996; American Association for the Advancement of Science, 1993; NGSS Lead States, 2013) make frequent use of the term "phenomena" to represent naturally occurring events with which students should engage. Many of the original TBEST items used this term as well. Teachers, however, largely interpreted "phenomena" quite differently, thinking instead of *supernatural* events; not at all what we had in mind. We felt compelled to remove the term from the questionnaire and use alternatives. The cognitive interviews suggested other edits but none as pervasive as this one. The months-long development process yielded just over 100 questionnaire statements, approximately 50 for each response-option format.

Pilot

Approximately 950 middle grades science teachers responded to the first pilot of the items, which was conducted online. A number of important and related findings emerged from the data. First, the four-point agreement response-option formats did not generate sufficient variation in teacher responses. (Several had no variation in responses and were eliminated from the survey.) Second, the data suggested that some respondents did not answer the questions thoughtfully. For instance, some individuals gave the same response to adjacent items that had

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[3] In order to explore relationships between beliefs and other factors, the instruments must be sensitive to variation in the constructs of interest.

opposite meanings. Our hypothesis was that the lack of thoughtfulness was due to the length of the questionnaire.

Based on the results, we chose the importance response-option scale and 23 items for the second phase of piloting, also conducted online. The items were chosen based on coverage of the content domain and variation in responses. Middle grades science teachers were recruited for participation, and an exploratory factor analyses (EFA) was conducted on the resulting sample of just under 250 respondents. The EFA was run using an oblique rotation,[4] which allowed any underlying factors to correlate. The analysis suggested five factors, which, based on the items, were labeled: (1) the importance of situating learning; (2) the importance of using evidence in sense making; (3) the importance of connecting new learning and prior learning; (4) the importance of using activities to confirm concepts that have already been taught (which we refer to as confirmatory instruction); and (5) the importance of hands-on instruction. However, some of the factors were highly correlated (e.g., the correlation between situating learning and confirmatory instruction was –0.57), causing concern about whether the factors were indeed distinct dimensions.

In order to assess the robustness of the five-factor structure, a third pilot was conducted. At this point, we addressed a disconcerting feature of the survey. Although the importance response-option format produced sufficient variation in responses, it seemed a force fit for many of the statements, requiring respondents to mentally alter the item or the response options to create alignment. Rather than continue with this response-option format, we returned to the agreement format but expanded it to six points, rewording the items to make them appropriate for the response options. The result was much better alignment between the items and the response options.

Approximately 250 middle grades science teachers responded to the new version of the questionnaire. Using the five-factor solution suggested by the EFA, a confirmatory factor analysis (CFA) was performed. However, the CFA results did not support the five-factor solution, and follow-up analyses suggested a three-factor solution was more appropriate. The three factors were conceptually coherent and were labeled: (1) Learning-theory-aligned science instruction; (2) Confirmatory science instruction; and (3) All hands-on all the time.

Next, we investigated the psychometric soundness of the survey's underlying structure across administration modes (paper versus online) and grade levels (K–12). In the first of these studies, just over 600 teachers were randomly assigned to receive either an online or paper version of the instrument. The previous pilots had been exclusively online; however, we anticipated that other researchers might prefer a paper-and-pencil version. Therefore, it seemed important to establish that similar results would be obtained regardless of administration mode. We decided to conduct an EFA on data from the paper version followed by a CFA on data from the web version. The same three-factor solution fit for both modes of administration, and there were no statistically significant differences in factor composite means, suggesting that the instrument produces similar scores regardless of whether it is administered on paper or online.

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[4] Using Direct Oblimin in SPSS version 19.

We were also interested in the robustness across grade levels, anticipating that researchers might want to use the TBEST in studies of elementary, middle, or high school science teaching. A final study was designed in which we administered the TBEST to a total of 900 elementary, middle, and high school teachers. To test whether the factor structure was the same across grade levels, a multiple-group CFA procedure was followed. This procedure involves conducting an initial CFA for each grade range separately, followed by a multiple-group CFA.

The individual grade-range CFAs pointed to the previously identified three-factor structure. Modification indices provided by the software identified two items that did not fit well with the three-factor structure, and these items were subsequently dropped from the survey. The adequacy of model fit for each grade range was assessed. Typically researchers examine a number of indices, using a somewhat holistic approach to judging model fit (Schumacker & Lomax, 1996). For this analysis, we used the fit indices available in the software package (Mplus 5.2): the Chi-Square Goodness of Fit test, the CFI, the TLI, and the RMSEA.[5] A significant Chi-Square test indicates that the model is not an adequate fit of the data; however, this test is very sensitive to sample size, and with the large samples used in our study, is not a good measure of fit (Tabachnik & Fidell, 2007). The research community has debated the best criteria for judging fit on each of the remaining indices. We elected to use the traditional criteria, where a good fit is defined as: CFI > 0.9, TLI > 0.9, and RMSEA < 0.08 (Browne & Cudeck, 1993). As can be seen in Table 2, the fit indices provide evidence of the appropriateness of the three-factor solution for each grade range.

Table 2
CFA Model Fit Indices by Grade Range Model

	Chi-Square Goodness of Fit test	**CFI**	**TLI**	**RMSEA**
Criteria for good-fit:	*Not statistically significant*	*> 0.9*	*> 0.9*	*< 0.08*
Elementary	$\chi^2(71, N = 332) = 207.319, p < .01$	0.929	0.940	0.076
Middle	$\chi^2(64, N = 262) = 149.210, p < .01$	0.940	0.949	0.071
High	$\chi^2(75, N = 372) = 257.461, p < .01$	0.912	0.930	0.081

Because not all response options were chosen by respondents in each grade range, it was not possible to run the multi-group CFA. However, other results provide support for the same three-factor model for each grade range. First, the factors were not highly correlated with each other, suggesting distinct constructs. (See Table 3.) Furthermore, the reliabilities (Cronbach's alpha) of the composites for each grade range are above 0.70. (See Table 4.) These findings were consistent across all grade ranges.

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[5] These fit indices are typically referred to in abbreviated form. The formal names of the fit indices are: CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation. For more information about each fit index, see Tabachnick & Fidell, (2007).

Table 3
Correlations among Factors[†]

	Learning-Theory-Aligned Science Instruction	Confirmatory Science Instruction	All Hands-on All the Time
Learning-Theory-Aligned Science Instruction	1.00		
Confirmatory Science Instruction	-0.18	1.00	
All Hands-on All the Time	-0.07	0.45	1.00

[†] Factor correlations were similar across grade ranges

Table 4
Cronbach's Alpha Reliability Coefficients by Grade Range Taught

	Grade Range			
	Overall (N = 966)	Elementary (N = 332)	Middle (N = 262)	High (N = 372)
Learning-Theory-Aligned Science Instruction	0.713	0.766	0.739	0.761
Confirmatory Science Instruction	0.771	0.758	0.775	0.784
All Hands-on All the Time	0.758	0.794	0.747	0.732

To summarize, the resulting questionnaire contains 21 items using a six-point agreement response scale. The items fall into three factors: (1) Learning-theory-aligned science instruction; (2) Confirmatory science instruction; and (3) All hands-on all the time. Statistical findings support the psychometric structure of the survey across different modes of administration and across teachers of various grade ranges. Table 5 shows the items organized by factor. A copy of the instrument is available in the appendix.

Table 5
Questionnaire Factors and Associated Items

Factor 1: Learning-Theory-Aligned Science Instruction (11 items)

Q3: Students should rely on evidence from classroom activities, labs, or observations to form conclusions about the science concept they are studying.
Q6: Teachers should provide students with opportunities to connect the science they learn in the classroom to what they experience outside of the classroom.
Q7: Teachers should ask students to support their conclusions about a science concept with evidence.
Q9: At the beginning of instruction on a science concept, students should have the opportunity to consider what they already know about the concept.
Q11: Teachers should provide students with opportunities to apply the concepts they have learned in new or different contexts.
Q12: Students should use evidence to evaluate claims about a science concept made by other students.
Q14: At the beginning of lessons, teachers should 'hook' students with stories, video clips, demonstrations or other concrete events/activities in order to focus student attention.
Q15: Students' ideas about a science concept should be deliberately brought to the surface prior to a lesson or unit so that students are aware of their own thinking.
Q17: Students should have opportunities to connect the concept they are studying to other concepts.
Q18: Students should consider evidence that relates to the science concept they are studying.
Q21: Students should consider evidence for the concept they are studying, even if they do not do a hands-on or laboratory activity related to the concept.

Factor 2: Confirmatory Science Instruction (7 items)

Q1: At the beginning of instruction on a science concept, students should be provided with definitions for new scientific vocabulary that will be used.
Q2: Hands-on activities and/or laboratory activities should be used primarily to reinforce a science concept that the students have already learned.
Q5: Teachers should explain a concept to students before having them consider evidence that relates to the concept.
Q10: Students should do hands-on activities after they have learned the related science concepts.
Q16: Teachers should provide students with the outcome of an activity in advance so students know they are on the right track as they do the activity.
Q19: When students do a hands-on activity and the data don't come out right, teachers should tell students what they should have found.
Q20: Students should know what the results of an experiment are supposed to be before they carry it out.

Factor 3: All Hands-on All the Time (3 items)

Q4: Teachers should have students do hands-on activities, even if the data they collect are not closely related to the concept they are studying.
Q8: Students should do hands-on or laboratory activities, even if they do not have opportunities to reflect on what they learned by doing the activities.
Q13: Teachers should have students do interesting hands-on activities, even if the activities do not relate closely to the concept being studied.

Using the Questionnaire

The TBEST, like any social science measure, is vulnerable to social desirability bias—the tendency for a respondent to provide answers that are consistent with social norms. In this questionnaire, if a researcher attended to the learning-theory-aligned composite score exclusively, a high score could indicate a teacher whose beliefs about effective science instruction were either truly aligned with cognitive learning theory or a teacher who answered affirmatively to the items because s/he thought those responses were the most socially acceptable. To distinguish between these possibilities, a researcher would benefit from considering the profile of three composite scores provided by the TBEST. A teacher whose beliefs about effective science instruction were aligned with cognitive learning theory would score high on the Learning-Theory-Aligned-Instruction factor and score low on the Confirmatory Science Instruction and All Hands-on All the Time factors. Considering the profile of scores on all three factors allows for a more nuanced understanding of a teacher's beliefs.

Citing the TBEST

In any writing in which data from HRI's TBEST questionnaire are included, the following citation should be used:

Smith, P. S., Smith, A. A., & Banilower, E. R. (2014). Situating beliefs in the theory of planned behavior: the development of the teacher beliefs about effective science teaching questionnaire. In C. M. Czerniak, R. Evans, J. Luft, & C. Pea (Eds.), *The Role of Science Teachers' Beliefs in International Classrooms: From Teacher Actions to Student Learning* (pp. 81–102). Rotterdam, The Netherlands: Sense Publishers.

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Appendix

Teacher Beliefs about Effective Science Teaching (TBEST) Questionnaire

Questionnaire Instructions:
This questionnaire asks you to respond to 21 statements regarding your beliefs about effective science instruction; that is, what does science instruction that helps students learn science concepts well look like?

Teachers have to make many trade-offs when they are responsible for teaching many standards in one year. Teachers may not be able to emphasize the instructional strategies they believe are effective and still cover the entire curriculum. When you respond to the statements below, please try to put those trade-offs aside. Imagine that you are not constrained by state/district standards, or available time/resources, or feasibility issues. What does effective science instruction look like, without all the constraints that limit what you can do in the classroom.

When responding to the statements, please try to think about students in general, not one student or a particular group of students.

Finally, this questionnaire makes frequent use of two terms that teachers may interpret differently depending on the context. For the purpose of this questionnaire, please use the following definitions of "data" and "evidence."

Data—information that has not yet been analyzed or processed; typically gathered through observation or measurement.
Evidence—analyzed or processed data that are used to support a scientific claim or conclusion.

These definitions are repeated on each page of the questionnaire.

Data—information that has not yet been analyzed or processed; typically gathered through observation or measurement.
Evidence—analyzed or processed data that are used to support a scientific claim or conclusion.

TBEST Questionnaire

Practical constraints aside, do you agree that doing what is described in each statement would help most students learn science?

Circle one in each row.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately agree	Strongly Agree
1. At the beginning of instruction on a science concept, students should be provided with definitions for new scientific vocabulary that will be used.	1	2	3	4	5	6
2. Hands-on activities and/or laboratory activities should be used primarily to reinforce a science concept that the students have already learned.	1	2	3	4	5	6
3. Students should rely on evidence from classroom activities, labs, or observations to form conclusions about the science concept they are studying.	1	2	3	4	5	6
4. Teachers should have students do hands-on activities, even if the data they collect are not closely related to the concept they are studying.	1	2	3	4	5	6
5. Teachers should explain a concept to students before having them consider evidence that relates to the concept.	1	2	3	4	5	6
6. Teachers should provide students with opportunities to connect the science they learn in the classroom to what they experience outside of the classroom.	1	2	3	4	5	6
7. Teachers should ask students to support their conclusions about a science concept with evidence.	1	2	3	4	5	6
8. Students should do hands-on or laboratory activities, even if they do not have opportunities to reflect on what they learned by doing the activities.	1	2	3	4	5	6
9. At the beginning of instruction on a science concept, students should have the opportunity to consider what they already know about the concept.	1	2	3	4	5	6
10. Students should do hands-on activities after they have learned the related science concepts.	1	2	3	4	5	6

Data—information that has not yet been analyzed or processed; typically gathered through observation or measurement.
Evidence—analyzed or processed data that are used to support a scientific claim or conclusion.

Circle one in each row.

		Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately agree	Strongly Agree
11.	Teachers should provide students with opportunities to apply the concepts they have learned in new or different contexts.	1	2	3	4	5	6
12.	Students should use evidence to evaluate claims about a science concept made by other students.	1	2	3	4	5	6
13.	Teachers should have students do interesting hands-on activities, even if the activities do not relate closely to the concept being studied.	1	2	3	4	5	6
14.	At the beginning of lessons, teachers should 'hook' students with stories, video clips, demonstrations or other concrete events/activities in order to focus student attention.	1	2	3	4	5	6
15.	Students' ideas about a science concept should be deliberately brought to the surface prior to a lesson or unit so that students are aware of their own thinking.	1	2	3	4	5	6
16.	Teachers should provide students with the outcome of an activity in advance so students know they are on the right track as they do the activity.	1	2	3	4	5	6
17.	Students should have opportunities to connect the concept they are studying to other concepts.	1	2	3	4	5	6
18.	Students should consider evidence that relates to the science concept they are studying.	1	2	3	4	5	6
19.	When students do a hands-on activity and the data don't come out right, teachers should tell students what they should have found.	1	2	3	4	5	6
20.	Students should know what the results of an experiment are supposed to be before they carry it out.	1	2	3	4	5	6
21.	Students should consider evidence for the concept they are studying, even if they do not do a hands-on or laboratory activity related to the concept.	1	2	3	4	5	6